

GoB-Danida Agricultural Sector Programme Support (ASPS)

**Environmental Impact Assessment of GNAEC Freshwater
Prawn (*Macrobrachium*) Farming Promotion**

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Acronyms

ASPS	Agricultural Sector Programme Support
ASPS	Agriculture Sector Programme Support
CDP	Chars Development Project
CDSP	Char Development Settlement Project
CE	Critically Endangered,
Char	Emergent land from the river sediment deposit/accretion process areas
CPUA	Catch per Unit of Area
CPUE	Catch per Unit of Effort
DAE	Department of Agriculture Extension
DoF	Department of Fisheries
Dogi	Floodplains
EIA	Environmental Impact Assessment
EMP	Environmental Management Plan (Danida)
FPSU	Fishery Program Support Unit
GNAEC	Greater Noakhali Aquaculture Extension Component
GoB	Government of Bangladesh
HH	household
HYV	High Yielding Variety
ICZM	Integrated Coastal Zone Management (Project)
IPM	Integrated Pest Management
IUCN	International Union for Conservation of Nature
MoFL	Ministry of Fisheries and Livestock
NGO	Non-Government Organization
PBAEC	Patuakhali-Barguna Aquaculture Extension Component
PBAEP	Patuakhali and Barguna Agriculture Extension Project
PL	Prawn Post Larvae
PPSU	Policy Planning Support Unit
PRA	Participatory Rural Appraisal
PRA	Participatory Rural Appraisal
Pucca	Concrete
SW	Southwest (Bangladesh)
USD	US Dollar

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Executive Summary

Findings

- ***Environmental - Biodiversity Impact.*** The GNAEC programme to expand prawn production does not appear to have a significant negative impact on biodiversity. The proposed locations are artificial wetlands created as a result of water logging. Polderization and infrastructure projects that predate the GNAEC have greatly degraded the natural ecosystem in these areas and have resulted in the creation of the wetlands in question. These wetlands include *Dogi* or floodplains and *Char* which is emergent land from river sediment. Out of the total 70 fish species found in the survey of the GNAEC prawn promotion areas, 8 species are identified as vulnerable, 6 species are endangered, and one species is critically endangered according to the IUCN red book. However, the proposed intervention is not likely to severely impact the ability of these species to survive.
- ***Environmental – Resource Exploitation.*** The production system proposed by GNAEC calls for an extensive approach. The study team further suggests that a minimal use of supplemental feeds could help maximize profits while minimizing demand for wetland / aquatic resources for use as feeds and reduce negative environmental impact.
- ***Negative Household Impact.*** The proposed prawn programs will have negative consequences in terms of income and resources lost to households that access dogi and char resources during the fallow inundation period. There is a population of about 100,000 households surrounding the proposed intervention areas. About 85,000 of those households use products from the wetland areas. However, about 65,000 of these households have land and an opportunity to participate in prawn culture. The potential exists for about 20,000 households to have reduced access to wetland products and also not be in a position to participate in prawn cultivation (due to a lack of suitable land). This assumes that the entire targeted area (56,000 Ha) is brought under prawn cultivation. Of these 20,000 potentially impacted households about 6,500 will be marginally impacted and 4,000 moderately impacted.¹ These impacted target households are primarily fisher families.
- ***Positive Economic Impact.*** The positive economic impact will far exceed the returns to the current land use pattern. The returns are at least 3 to 4 times greater than the current land use returns. The returns to extensive prawn culture are about Tk. 60,000/Ha while the value of aquatic products gathered from wetlands does not exceed Tk. 4,000 per household. Significant secondary employment will also be generated in the input supply chain (prawn post larvae = PL), production (for construction and maintenance) and in the output market chain.
- ***Land Tenure Status.*** In the primary *Dogi* areas where this activity is to be undertaken land tenure status is relatively strong as land belongs to families that have had long term ownership. Most people in these areas have gained title to the land through inheritance. These households reported few harassing lawsuits on land ownership and felt secure in their land rights. However, in the nearby char areas a significant number of landholders report insecurities in their land tenure status.

¹ Marginal impacted means that less than 10% of income comes from the wetlands, moderately impact is for 20%, and severely is for over 30% of income from the wetlands. No households in the survey would be severely impacted.

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Recommendations

Overall the study team recommends that GNAEC program for prawn cultivation cautiously proceed. The potential economic benefits are very large while environmental and negative social impacts are minimal or can be minimized. To ensure effective implementation of the programme in accordance with Danida and ASPS objectives the following specific recommendations are made:

- **Monitoring.** A monitoring plan should be put in place to make sure that programme interventions are in fact not having significant negative impacts. This plan should include a biodiversity /fisheries monitoring plan within then context of the Danida Environmental management Plan (**Annex C**) and a programme for the component to repeat the household survey after 2 years of implementation. In practice to implement this activity a small unit should be established within the component to document the changes due to the intervention of prawn fish culture in the *Dogi* and Char lands .
- **Extensive Production.** It is recommended that the production systems being promoted not be based on the use of supplemental feed. This is consistent with both profit maximization and minimizing environmental impact. Fisheries experts working on this study have concluded that much of the supplemental feed provided in extensive systems is not productively employed and in fact represents a waste of resources. In the process of promotion, demonstration trials should be undertaken to show that limited input systems can yield higher profits.
- **Programme Targeting.** GNAEC should ensure that participants are members of the Danida target group. To facilitate the formation of *Dogi*-wise prawn & fish culture, organizations where the poorest section of the community are included as members should be promoted. GNAEC should continue to develop linkages between these groups and the private PL hatcheries.
- **Negative Impact Mitigation: Income programme.** The programme will have a significant negative impact on a limited number of families that harvest fish and collect aquatic products from the wetlands under the current seasonally fallow regime. These families (primarily fisher families) should be extended programme activities to increase their incomes through alternative income sources. These activities should include PL transport, harvesting and marketing associations.
- **Infrastructure Issues.** The GNAEC should discourage construction of dikes on each plot boundary within the *Dogi*. Arrangements should be made to reduce monsoon drainage congestion. GNAEC can also assist in the identification of areas suitable for bio-diversity conservation (sanctuaries) where the prawn cultivation is not undertaken. These could be rotating in nature.
- **Land Tenure.** The programme should be undertaken only in areas where smallholders have secure rights to the land. This occurs where land is primarily inherited and not provided through the government. In these and other program areas GNAEC should facilitate institutional and legal support for poor households (HHs) recently acquired land.

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- ***Concentrate in Dogi areas.*** The study team recommends that primary emphasis be placed on *Dogi* areas (as opposed to *char* areas). Farmers have more secure land rights. This is consistent with the current GNAEC plan.

The Danida Environmental Management Plan (EMP)

This study was undertaken as an activity to fulfill specific areas of the Danida Environmental Management Plan (EMP) mandates. The mandates that this study fulfils or partially fulfill include:

- ***Action No. 10: Awareness and Policy Guidance on Biodiversity, Exotic Species and Disease (all components):*** The study details the numbers of endangered species present and the minimal impact on these species and develops a monitoring protocol for component staff to follow.
- ***Action No. 11: Responsible Use of Chemicals (All Components).*** The prawn cultivation approach recommend does not require the use of chemicals and in fact restricts the use of chemicals (pesticides) on associated rice crops.
- ***Action No. 12: Indigenous Species Aquaculture (All Components).*** The recommended production system is for prawns native to Bangladesh wetlands.
- ***Action No. 13: Environmental Management for Prawn Aquaculture (GNAEC and PBAEP).*** This study provides a strong recommendation to promote an extensive system using minimal feed inputs.
- ***Action No. 14: Rice-fish Culture (all components) systems based on IPM for rice crops.*** IPM systems must be used for rice production associated with prawn cultivation.

1.0 Introduction

1.1 The GNAEC Prawn Promotion Programme

The Greater Noakhali Aquaculture Extension Component (GNAEC), a GoB component is being implemented with assistance from Danida. The aim of the component is to extend fish culture technologies involving carp polycultures and to a lesser extent rice-fish culture. The component is also promoting freshwater prawn (*Macrobrachium rosenbergii*) farming in carp polyculture systems and is also piloting a programme for rice-prawn culture. The rice-prawn culture is being undertaken in selected rice fields and is the subject of this impact study. The component emphasizes strong linkages between prawn hatcheries, supported with technical assistance, and smallholder producers. The component is providing technical assistance to the private entrepreneurs for the construction and operation of the prawn hatcheries. It is expected this will ensure wider adoption of the technology at for targeted and non-targeted farmers and mitigate the problems caused by the collection of wild prawn fry.

A study conducted by GNAEC found that an area of about 55,000 ha of land in the Greater Noakhali area located in low-lying areas - in *Dogi* and protected *Char* areas - is suitable for rice prawn cultivation. In the past farmers grew double crops of local Aus and Aman in this area. The polderization process, lead to siltation in the rivers/channels, slowing drainage in these low-lying areas and creating seasonal water logging for 68 months in a year. This situation changed the cropping pattern especially in the *Dogi* areas, where farmers now use their lands mostly for one rice crop in the dry season. Rice cultivation during the dry season is not easy due to the lack of surface water irrigation facilities and intrusion of salt water in local aquifers. The situation is worse in water logged *Char* land areas where they grow rain fed Aus/Aman and no rice crop in dry season.

The expansion of freshwater prawn culture in seasonally flooded areas, however, may give rise to social and environmental concerns that have been documented elsewhere in Bangladesh. These concerns include:

- Loss of biodiversity and seasonal natural habitat;
- Increased prawn PL and fry collection from the wild fishery and destruction of non-target species whilst they are collected;
- Destruction of snail populations as they may be used for prawn feed;
- The loss of access rights to waterlogged land (wetland) areas for the poor people of the community who fish and collect aquatic products when these areas are inundated; and
- Possible pressure from the local 'elite' to gain access of land title deeds in prawn farming areas due to the high returns.

The expected expansion of prawn culture in a large area of seasonally flooded (waterlogged) land underscores the need for this impact baseline study, which will serve as a basis for the water logged rice field (wetland) management plan and baseline information for the impact assessment due to the component interventions. This Environmental Impact Assessment of GNAEC prawn promotion will contribute to planning for the seasonally water logged rice fields (wetlands). The study findings will also provide the basis for making further Environmental Management Plans.

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1.2 The Danida Environmental Management Plan (EMP)

The DoF/Danida Fisheries Programme Support Unit (FPSU) operating under the GoB/Danida Agricultural Sector Support Programme (ASPS) includes a mandate to follow an environmental management plan. This study is relevant to addressing the following EMP action mandates:

- **Action No 10:** Awareness and Policy Guidance on Biodiversity, Exotic Species and Disease (all components)
- **Action No 11:** Responsible Use of Chemicals (All Components)
- Action 12 Indigenous Species Aquaculture (All Components)
- **Action No 13:** Environmental Management for Prawn Aquaculture (GNAEC and PBAEC)
- **Action No 14:** Rice-fish Culture (all components) systems based on IPM for rice crops

The study addresses concerns of actions 10, 11, 12, 13, and 14. It represents the implementation plan for Action No 13: Environmental Management for Prawn Aquaculture for GNAEC and methods and results can be extended for PBAEC. The full description of Action No 13 is provided in **Annex A**.

1.3 Bio-physical Situation

Bangladesh Floodplains are rich in natural resources and biodiversity and form the basis of one of the most productive ecosystems in the country. A large variety of plants, insects, amphibians, reptiles, birds, fish, and other wildlife depend on these seasonally flooded areas. Flooded lands play a critical role in regulating the ecosystem's within inundated areas. These areas are characterized by water saturation in the root zone (at or above the soil surface) for certain periods of time during the year. This fluctuation of the water above the soil surface is unique to each flooded land area and contributes to maintain the productivity of the land. Waterlogged land (wetland) products have a vital role in the environment and are a critical source of food and income and ecosystem services for the rural poor.

Fisheries Resources

In the program area fisheries resources are important primarily in terms of production and to a lesser extent in bio-diversity. There are also a number of perennial wetlands with important fish habitats. There are about 100,000 households surrounding the 55,000 Ha of proposed project intervention areas. Of these about 85,000 households harvest some products from the wetland areas.

Presently most of the canals and rivers in the program area are silted up due to unplanned development interventions² and some perennial wetlands have become seasonal. This process has resulted in reduced fish habitats and blocked fish and prawn migration routes.

In Bangladesh in general capture fish production and wetland bio diversity are declining due to a lack of dry season refuges, lack of brood fish, increased fishing pressure and habitat destruction. In addition due to over fishing, use of destructive fishing methods, and use of pesticides capture fish production has sharply declined in the past 15-20 years. Estimates are that the freshwater capture fishery will continue to decline by 0.9 to 2.1% per annum over the next 10 years³. It should be

² Prior to the GNAEC

³ Fishery Sector Review and Future Developments 2003

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stressed that these developments are not related to the Danida programme but are the result of country and regional infrastructure put in place by other projects.

Crab and Mollusk

The GNAEC area is rich in various species of both commercially important (e.g. *Scylla serrata*, *Portunus pelagicus*) and other crabs in the saline, brackish and fresh water areas. Commercially important crabs heavily fished almost exclusively for export putting pressure on natural stocks. Habitat degradation and pollution are also affecting the natural stocks. Pesticide use in crop fields is very harmful to crabs and mollusks.

This area has in the past also been rich in the commercially important apple snail, edible mussels, pearl oysters, and other mollusks. Fresh water apple snail (*Pila globosa*) populations are decreasing due to over use because of poultry feed demands. In addition this resource may be under threat due to the indiscriminate use of pesticides and more importantly the continuing loss of wetland habitats to agriculture.

Reptiles and Amphibians

There was an abundant stock of frogs, turtles, snakes and other reptiles in these areas. Turtles and frogs were valuable as an export item. These are still captured in small numbers but officially their capture and sale is now banned.

1.4 Physical Setting

Landscape position

The proposed component area for prawn and fish culture is categorized in broad two types. These are (i) waterlogged wetland *Dogis* (floodplain) having a number of canals formerly interlinked with the rivers flowing through the component areas; and (ii) waterlogged *Char* lands (waterlogged) on newly accreted land inhabited about 15-20 years back.

Landscape position determines the amount and source of water in a specific rice field. In these *Dogi* areas seasonal water stagnation due to blocked canals and improperly constructed drains are a major feature. Most waterlogged rice fields are in low lying areas (*Dogi*) within the GNAEC area and dominated in the monsoon by the build up of rain water. In *Char* areas tidal inundation plays an active role in contributing to seasonal inundation.

Land type and hydrology

The area of concern the project is in the deeper part of the floodplains is referred to locally as *Dogi* Land within the *Dogi* is now a single cropped, with HYV *Boro* (dry season) rice which requires more water during the dry season. During the monsoon these *Dogis* are fully inundated. Water stands for a period of 68 months in the *Dogis* and its associated flood plains where the average water depth is about 1-1.5 meters whilst water depth is only 0.60cm in *Char* areas. Farmers cannot cultivate any crop in the *Dogi* after harvest of *Boro* crops. During the dry season farmers also suffer from lack of surface water for irrigation. In *Char* area they grow *Aman* (rainy season) rice in most of the land area, *Aus* (early monsoon) rice in a small area with *Boro* rice covering only a negligible areas. **Figures 1 and 2** show the *Dogi* and *Char* areas.

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Figure -1 : GNAEC water long rice fields in *Dogi* area.



Figure -2 : GNAEC water logged rice fields in *Char* area.



In the monsoon the areas became similar to beels or lakes due to poor drainage. The people around the water body use the waterlogged lands as a common property resource. In the flooded areas, water resources have a vital importance in maintaining the productivity of the land for agriculture, fish and aquatic products. In the waterlogged lands the density of aquatic vegetation provides habitat, spawning sites and shelter for many animals. Hunting and gathering activities in the waterlogged lands have increased over time to meet the requirements of a growing population.

Such lands are mostly privately owned by marginal farmers. At present during the monsoon a variety of aquatic plants grow in the area and these are used by local people, mainly the poor, who collect them for different uses. Some of the vegetation is used as a direct food and some are used for fodder, medicinal and other uses.

Presently GNAEC is promoting prawn cultivation in waterlogged rice fields in *Dogi areas as well as some* protected *Char* areas. They are providing technology targeted individuals and at the community level in some areas. GNAEC also continues to promote private sector hatcheries to produce fish and prawn fry. In Noakhali a number of small hatcheries for carps and other fish and two large hatcheries for prawn have been established. These hatcheries are capable of meeting the current prawn demand in the component area.

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1.5 Socioeconomic Situation

Demography

From the study it appears that Noakhali is comparatively more densely populated than the average. The average family size in the study area is 7.5 persons while the national average is 5.6 (Census 1991). However, the family size is bigger in *Char* areas than that in the old settled waterlogged area (*Dogi*). **Table 1** provides detailed information about the family composition in the component area.

Table 1: Family size in *Dogi* and *Char* areas.

Strata	Total no. of sample HHs	Average size of HH (members)	No. of adult members per household (HH)		No. of children (below 15 years) per HH	
			Male	Female	Male	Female
<i>Dogi</i> poor	50	5.8	2.0	1.6	1.1	1.1
<i>Dogi</i> non-poor	85	8.3	3.0	2.2	1.6	1.5
<i>Char</i> poor	14	6.2	1.6	1.4	1.7	1.4
<i>Char</i> non-poor	34	8.6	2.3	2.0	2.2	2.3
Total	180	7.5	2.5	2.0	1.6	1.5

Source: Study field survey in the GNAEC area, 2003.

Livelihood strategies and assets

Cyclones, floods, river erosion and other natural calamities have been very common in the Greater Noakhali area. To cope with this situation, people of the region have adopted different strategies for their livelihoods. Perhaps the most common coping strategy in this area is migration out of the area. Noakhali people are well known for working outside the region in a variety of jobs, including various day labor activities, construction, transport, industrial laboring, petty trading, other jobs in the public and private sectors. In the recent past people of this area started different income generating activities (IGAs) supported by private and public sector institutions. These activities were further intensified with the large scale infrastructure interventions and technological developments supported by development partners. The GNAEC intervention has created a potential for aquaculture as a poverty reduction activity for the rural population.

It is apparent that the people in the *Dogi* areas own more assets than the people in *Char* areas. The survey indicates that on an average a poor household (HH) in a *Dogi* area owns assets worth Tk. 308,414 and a non-poor HH worth Tk. 1,321,212, while a poor HH in *Char* area owns assets worth Tk.170,912 and an non-poor owns assets worth Tk. 363,392. **Table 2** shows details of ownership of assets.

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Table 2: Family size assets and income of target and non target HHs.

Strata	Number of cases (samples)	Value of assets in taka				Annual average income	Daily income in USD
		Ag land per HH	Non-ag land Per HH	Others assets	Total assets per HH		
<i>Dogi</i> poor	50	147,374	105,565	55,475	308,414	27,369	1.29
<i>Dogi</i> non-poor	85	592,012	561,065	168,136	1,321,212	126,506	5.98
<i>Char</i> poor	14	98,379	50,236	22,298	170,912	31,164	1.47
<i>Char</i> non-poor	31	200,827	115,306	47,259	363,392	77,246	3.65

Source: Field Survey in the GNAEC area, 2003.

The study survey results indicate that land price differences in the two areas is correlated with the difference in the value of assets in the two areas – land price in *Dogi* areas are much higher than in the *Char* areas. Similarly the status of housing, sanitation and access to tube-well water is better in *Dogi* areas for both the poor and non-poor HHs compared to that in *Char* areas. Socio-economic details are given in **Tables A1, A2 and A3 Annex B**. It should be noted that the HHs from poor and non-poor categories in *Char* areas do have higher numbers of live stock and poultry than the HHs of the same categories in *Dogi* areas. Availability of cattle feed and grazing land in *Char* areas is the main reason for this; cattle in the *Dogi* mostly depend on aquatic grasses and purchased straw. **Table 3** shows the ownership and value of livestock by HH and strata.

Table 3: Livestock ownership by HH and strata.

Strata	No. of smpl. HHs	No. of HHs owning livestock (% of total HHs)	Ownership of cattle		Ownership of sheep/goat		Ownership of poultry birds	
			No. of HH (% of HHs)	Average value (Tk.)	No. of HH (% of HHs)	Average value (Tk.)	No. of HH (% of HHs)	Average value (Tk.)
<i>Dogi</i> poor	50	18 (36.0)	16 (32.0)	7,125	4 (8.0)	613	47 (94.0)	458
<i>Dogi</i> non-poor	85	49 (57.6)	47 (55.3)	9,594	6 (7.1)	1,117	83 (97.6)	965
<i>Char</i> poor	14	9 (64.3)	8 (57.1)	8,750	1 (7.1)	650	13 (92.9)	844
<i>Char</i> non-poor	31	22 (71.0)	19 (61.3)	8,542	7 (22.6)	2,271	31 (100)	1,519
Total	180	98 (54.4)	90 (50.0)	8,858	18 (10.0)	1,428	174 (96.7)	918

Source: Field Survey in the GNAEC area, 2003.

The income of a poor HH in *Char* area is higher than that of a poor HH in *Dogi* areas, while the income of a non-poor HH in *Dogi* area is higher than that of a non-poor HH in *Char* area. **Table 2** (above) shows the annual average income by HH and strata. The main reasons for the higher

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income of poor HHs in *Char* areas are: bigger holding of agricultural land, higher numbers of livestock and poultry birds, out-migration for laboring and locally available employment opportunities in construction of *ghers* during the lean period. The main reasons for higher income of non-poor HHs in *Dogi* areas are: involvement in non-farm activities and fish-culture. The changes in socio economic condition of the HHs in *Dogi* and *Char* areas over five years are shown in **Table 4**. Major improvements took place in *Char* areas while the situation for the poor in *Dogi* areas have worsened further.

Table 4: Changes in HH socio-economic conditions over the last 5 years.

Strata	Total no. of HHs.	Socio-economic conditions of different HHs as compared to the past		
		Improved (% of the total HHs)	Remained same (% of the total HHs)	Worsened (% of the total HHs)
<i>Dogi</i> poor	50	17 (34.0)	14 (28.0)	19 (38.0)
<i>Dogi</i> non-poor	85	48 (56.5)	24 (28.2)	13 (15.3)
<i>Char</i> poor	14	9 (64.3)	2 (14.3)	3 (21.4)
<i>Char</i> non-poor	34	20 (52.2)	8 (25.8)	3 (9.7)
Entire PoP	180	94 (52.2)	48 (26.7)	38 (21.1)

Source: Field Survey in the GNAEC area, 2003.

2.0 Methods

The study relied on household surveys, participatory rural appraisal (PRA) tools – focus group discussions (FGDs), transect walks, key informant interviews, and GNAEC component monitoring data (**Table 5**). These methods were used to calculate the annual income per HH by stratum considering all the major sources of incomes – from agriculture, livestock and other activities and assets. The study considered the incomes (economic values of products) generated from the waterlogged areas in *Dogi* and *Char*, as follows:

- Harvest of open water fisheries;
- Harvesting of aquatic non-fish products, and
- Land use for rice crops.

A multi disciplinary team consisting of five core members conducted the study; (1) One Agricultural Economist (ii) One Wetland specialist (iii) Two Environmental Specialists and One Sociologist. In addition, a total of 10 field enumerators were involved of which five senior enumerators from were from Winrock and five from the GNAEC.

Before the field survey, the study team visited many villages with waterlogged rice land in *Dogi* and *Char* areas to determine the physical situation and to understand the land use in terms of crop production and use of aquatic vegetation. Three villages were selected – 2 from *Dogi* areas and 1 from a *Char* area – so that they represent the waterlogged areas where people harvest aquatic products as well as grow rice. The two villages of *Dogi* areas are Ramdevpur of Sadar Upazila and Bazra of Begumganj Upazila, and the *Char* village is Nabagram of Sadar Upazila – all under Noakhali district

Based on the experience gathered from the village visits, a questionnaire was developed for a quantitative survey at the household level. It included questions on socio-economic, environmental and bio-diversity issues. This household level survey was conducted on 180 sample households, selected randomly from the three villages: 135 sample HHs from *Dogi* areas, and 45 samples HHs. from *Char* area. Prior to the survey the developed questionnaire was pre tested in the field and the enumerators were trained in the classroom and in the field.

For qualitative information checklists, formats and semi-structured questionnaires were developed. In this process FGDs were organized using checklists for harvesting groups of aquatic products and crop farmers – male and female. A transect walk along with villagers was done using formats. Discussions with key informants, Deputy Director, DAE, Noakhali, senior staff members of Char Development Settlement Project II (CDSPII), hatchery owners and fish buyers/*aarotdars* were conducted using checklists and semi-structured questionnaires. A series of long discussions took place in different villages with poor household members both male and female, especially with day laborers involved in earthwork for *gher* construction. Experience was shared also with rice fish entrepreneurs in order to assess the profitability, potentialities, risks, problems and social implications of the rice fish culture in waterlogged areas. After the completion of the field work the study team shared the initial findings with the project people and senior staff members of CDSP II. **Table 5** provides a summary of methods and activities for the study.

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Table 5: Field visit activities for qualitative information.

Activity	Description /outcome
Visit to waterlogged <i>Dogi</i> areas in Sadar and Begumganj Upazilas of Noakhali district	Team took component transport and visited many villages with waterlogged rice land in <i>Dogi</i> and <i>Char</i> areas to determine physical layout and to understand the land use – crop production and aquatic vegetation.
FGD with groups involved in harvesting of aquatic products including fish	Met with the groups involved in harvesting of aquatic products including fish to understand economic benefits from waterlogged areas. It was found that a good amount of non-fish aquatic materials is being harvested.
FGD with farmers	Met with a number of local farmer groups in <i>Dogi</i> and <i>Char</i> areas to understand economic benefits from crop cultivation. It was found that a large number of farmers also harvest both fish and non-fish aquatic materials.
FGD with poor/day laborer HHs	The study team organized a number of FGDs with poor/day laborer HHs and discussed many issues especially on crisis period, employment and wages. The laborers informed that January to April are the lean periods for their employment so that they usually migrate out in search of jobs. Construction of <i>ghers</i> has created employment for them with higher wage rates.
Transect walk through waterlogged agricultural fields	Jointly with the component staff a few transect walks through water – walking from one side of field boundary to another – were done to observe and list aquatic vegetation in <i>Dogi</i> and <i>Char</i> areas. A large variety of species of aquatic grass, vegetables, leaves, etc was found.
Visit to the office of the Deputy Director, Department of Agriculture Extension, Noakhali	From the visit to the office of the Deputy Director, Department of Agriculture Extension, Noakhali a calculation of waterlogged areas and its potentialities in cultivation of rice and fish were obtained.
Visit to <i>Char</i> Development Settlement Project (CDSP)	From the meeting with the CDSPII Staff members, the present status of settlers and problems of land distribution were learned. Potentiality and risks of GNAEC in <i>Char</i> areas were also discussed.
Visit to fish and prawn hatcheries	Fish and prawn hatchery owners indicated that demand for fingerlings, post larva (PL) and juveniles has increased significantly over last 1-2 years.
Visit to <i>aarots</i> /fish buyers	For both fish & prawn buyers and <i>aarot</i> owners indicated that both supply and demand have increased significantly over last 1-2 years. They further indicated that, if the supply increases further, then fish/prawn merchants will come from Dhaka and Chittagong rather than they taking them to the larger markets.
Visit to sites of <i>ghers</i> under construction	During the visit of <i>gher</i> -sites it was observed that many hundreds of laborers are engaged in earthwork for construction of <i>ghers</i> .
Visit to Rice Fish Entrepreneurs both at community and individual levels	Met with a number of farmers involved in rice fish culture at community and individual levels. The issues of profitability, potentialities, risks, problems and social implications were discussed.
Interactions with Component and NGO Staff	The study team had many interactions, experience sharing sessions and joint field visits. Potentialities and risks were discussed in detail.

Limitations and Study Issues

Due to resource constraints and time limitations the study could not cover a larger sample size – in terms of population and village coverage. The study was initiated at the receding time of flood water from waterlogged areas – at the last stage of aquatic product harvest. The study attempted to make an environmental impact assessment of GNAEC fresh water prawn cultivation but not the full economic valuation of waterlogged land. Not all benefits were identified in this study, nor all economic benefits identified were quantified. This results in an underestimation of the waterlogged land's economic output and value.

3.0 Results

3.1 Wetland Productivity

The study has included an effort to assess the economic valuation of the waterlogged wetland resource in the potential prawn-fish culture areas. The proposed potential area is about 52,000 hectares in *Dogi* and 4,000 hectares in *Char* areas. These lands are mainly located in Noakhali Sadar, Begamgonj, Chatkhil and Ramgonj Upazillas of greater Noakhali district.

An estimation of the value of wetland products is important when understanding the opportunity cost of the prawn cultivation. It is also important to know who the aquatic product users are and the purposes of collection of aquatic products. The estimation of overall value is a complex task. This study has attempted to assess the economic value of the wetland resources for the period from *Ashar* to *Agrahayan* months of the Bengali year (June to December). A comparative analysis has been made on existing output from the wetland and the estimated value from the proposed prawn and fish culture during the period of monsoon and post monsoon.

The study showed that many different types of aquatic products are collected from the waterlogged (wet) lands and about 84 percent of HHs in *Dogi* and *Char* areas are involved in harvesting of aquatic products during the months of *Ashar* to *Agrahayan*. It also appears that among the resource collectors, females and children from a large number of HHs in *Dogi* and *Char* areas are involved.

The survey data show that 84.4 percent of all HHs are involved in harvesting some aquatic products; 74.4 percent of HHs are involved in collecting fish, 72.2 percent in harvesting of vegetation/grass, 60.6 percent in collecting mollusks and 6.7 percent in catching birds (see Table-9). Further details regarding the collection of aquatic products have been shown in table 11. The survey data show that a higher percentage of HHs in the *Char* area is involved in fish catch rather than that of *Dogi* areas. It also shows that these wetlands are more important for the poor with higher percentages of poor HHs from both *Dogi* and *Char* areas involved in collecting aquatic resources other than fish than the non-poor HHs. The family size in the *Char* areas is bigger than that of the villages in and around the *Dogi* areas.

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Table 6: Harvesting of different types of aquatic products.

Strata	Total no. of HHs	Types of aquatic products harvested				
		HHs harvesting any aquatic product (% of total HHs)	HHs harvesting fish (% of total HHs)	HHs harvesting aquatic veg./ grass/ leaves (% of total HHs)	HHs harvesting mollusks (% of total HHs)	HHs harvesting birds (% of total HHs)
Dogi poor	50	40 (80.0)	35 (70.0)	36 (72.0)	30 (60.0)	4 (8.0)
Dogi non-poor	85	72 (84.7)	61 (71.8)	61 (71.8)	42 (49.4)	7 (8.2)
Char poor	14	13 (92.9)	12 (85.7)	11 (78.6)	12 (85.7)	1 (7.1)
Char non-poor	31	27 (87.1)	26 (83.9)	22 (71.0)	25 (80.6)	-
Total	180	152 (84.4)	134 (74.4)	130 (72.2)	109 (60.6)	12 (6.7)

Source: Field Survey in the GNAEC area, 2003.

Harvest of aquatic products is very seasonal and limited to the wet season with fish earning the highest among all items. The estimated values of harvested aquatic products are shown in **Table 7**. In terms of Taka the estimated value of the fish catch is the highest (TK 2,515), followed by aquatic leaves (TK 1,658), mollusks (Taka 1,309) and aquatic grass (Taka 446). Survey data also reflects that there is a variation between *Dogi* and *Char* areas and among the categories of HHs from poor and non-poor.

Table 7: Value of harvested aquatic products and annual income by HHs and strata.

Target Strata	Total no. of HHs.	No. of HHs harvesting aquatic products	Average income per HH from harvest of different aquatic products					Total average income from wetlands per HH (in Tk.)
			Fish (in Tk.)	Vegetable (in Tk.)	Grass (in Tk.)	Leaves (Tk.)	Mollusk (in Tk.)	
Dogi poor	50	40 (80.0)	1,244	250	1,370	450	503	2,233
Dogi non-poor	85	72 (84.7)	3,431	632	1,644	1,098	802	4,803
Char poor	14	13 (92.9)	2,003	153	1,634	1,756	495	4,100
Char non-poor	31	27 (87.1)	2,313	337	2,047	2,032	1,008	4,972
Total	180	152 (84.4)	2,515	446	1,658	1,309	733	4,097

Source: Field Survey in the GNAEC area, 2003.

Table 8 shows the comparative estimates of existing value of aquatic products and expected outcome from the proposed prawn and fish culture in the waterlogged wetlands. It indicates the per hectare economic return for aquatic products-rice combination and fish-rice combination.

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Table 8: Calculation of net economic return in Dogi and Char areas.

Types of waterlogged area		Harvest value of aquatic product/fish culture per hectare (Tk.)	Net profit from paddy and other Ag. products per hectare (Tk.)	Total income per hectare (Tk.)
Present situation	Dogi	6,167.00	10,000.00	16,167.00
	Char	3,448.00	7,000.00	10,448.00
Future potential situation	Dogi	30,600.00	10,000.00	40,600.00
	Char	30,600.00	7,000.00	37,600.00

Source: Field Survey and Monitoring Data of GNAEC, 2003.

From the present experience it appears that the potential economic return per unit area of land will increase at least 2.5 times in Dogi areas and at least 3 times in Char areas by adopting rice-white fish cultivation. In the case of prawn culture the economic return per unit area will be much higher.

Detailed information on total harvesting between *Ashar* to *Agrayan* and estimated value of harvested products is presented in **Table 9**. There is a wide variation in the number of days of collecting different types of products from waterlogged lands in *Dogi* and *Char* areas. It also shows variation in harvest days of aquatic products by poor and non-poor. The Table shows that during the harvesting period people are engaged for 80 days (highest number of days) for harvesting of aquatic grass, 72 days for collecting mollusks, 72 days for harvesting aquatic leaves and 50 days for catching fish.

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Table 9: Duration and seasonal variations in the harvest of aquatic products.

Aquatic Products	Strata (Number of HHs)	Period of harvest						Total no. of harvest days	Total value of harvest (in Tk.)
		Ashar to Srabon (15 June to 15 August)		Bhadra to Aswin (16 August to 15 October)		Kartik to Agrah (16 October to 14 December)			
		No. of days	Value of product (in Tk.)	No. of days	Value of product (in Tk.)	No. of days	Value of product (Tk.)		
Fish	Dogi poor (50)	11	19.37	13	22.29	13	25.37	37	1244
	Dogi non-poor (85)	19	37.46	22	45.16	19	40.08	59	3431
	Char poor (14)	20	47.50	20	44.58	13	54.17	43	2003
	Char non poor (31)	16	34.42	22	36.15	9	22.69	48	2312
	Total (180)	16	33.04	19	37.39	14	34.13	50	2515
Aquatic Vegetable	Dogi poor (50)	11	4.76	12	7.09	9	6.45	32	250
	Dogi non-poor (85)	11	10.89	11	11.91	6	8.32	29	632
	Char poor (14)	15	5.43	10	4.71	3	.57	28	153
	Char non poor (31)	19	6.50	13	5.42	5	2.08	38	337
	Total (180)	12	8.10	12	9.17	7	6.50	31	446
Aquatic Grass	Dogi poor (50)	28	14.23	25	12.38	19	15.38	72	1370
	Dogi non-poor (85)	31	18.83	31	18.14	22	12.00	84	1644
	Char poor (14)	28	10.00	43	21.40	10	8.00	81	1634
	Char non poor (31)	33	23.36	30	25.18	13	12.00	76	2047
	Total (180)	30	17.90	31	18.47	19	12.41	80	1658
Aquatic Leaves	Dogi poor (50)	12	7.60	13	7.60	16	18.60	40	450
	Dogi non-poor (85)	24	9.29	26	11.21	22	12.57	72	1098
	Char poor (14)	31	13.25	28	8.75	20	11.38	79	1756
	Char non poor (31)	36	21.82	33	19.09	8	9.09	78	2032
	Total (180)	26	12.84	25	11.93	17	12.86	68	1309
Mollusk	Dogi poor (50)	25	13.23	19	12.33	16	8.00	61	503
	Dogi non-poor (85)	28	9.31	25	8.52	20	9.93	74	802
	Char poor (14)	40	7.83	27	5.58	1	0.25	68	495
	Char non poor (31)	33	8.88	33	8.72	19	5.36	85	1008
	Total (180)	29	10.13	26	9.29	17	7.25	72	733
Birds	Dogi poor (50)	-	-	-	-	1	23.75	1	30
	Dogi non-poor (85)	4	24.29	3	28.57	8	51.43	15	899
	Char poor (14)	-	-	-	-	1	40.00	1	40
	Char non poor (31)								
	Total (180)	2	14.17	2	16.67	5	41.25	9	537

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3.2 Biodiversity Assessment

The large number of species of vegetation and fish in particular offers livelihood opportunities to the rural poor. The miscellaneous small fish species are a major source of protein for the poorer sections of the community.⁴ An attempt has been made to estimate the species diversity through a recall method through interviewing household members and through observational approach – transect walk on inundated land, during the survey.

The waterlogged areas in *Dogi* and *Char* areas in Noakhali district were historically connected to the river system and had a large number of species of vegetation and fish. The availability of aquatic products, including fish, has declined in the last 10 years. **Table 10** summaries trends in the last 10 years.

Table 10: Availability trend of aquatic products during last ten years.

Nature of aquatic products	No. (and %) of HHs that responded	Availability Trend – response of sample HHs		
		Reduced (% of total HHs)	Remained same (% of total HHs)	Increased (% of total HHs)
Fish	134 (74.4)	116 (64.4)	12 (6.7)	6 (3.3)
Aquatic Vegetable	105 (58.3)	78 (43.3)	22 (12.2)	5 (2.8)
Aquatic Grass	58 (32.2)	33 (18.3)	16 (8.9)	9 (5.0)
Aquatic Leaves	43 (23.9)	27 (15.0)	14 (7.8)	2 (1.1)
Mollusk	109 (60.6)	69 (38.3)	29 (16.1)	11 (6.1)
Birds	12 (6.7)	9 (5.0)	2 (1.1)	1 (0.6)

Source: Field Survey Data of GNAEC, 2003.

One of the reasons for decline is that systems are disrupted due to the construction of embankments along the rivers, construction of bunds in the khal system by encroachers, construction of water control structures and other unplanned interventions. The tables in **Annex B** provide additional details on trends.

The survey results provide an estimate of the number of species that are found in the target areas. A total of 70 fish species have been recorded in the survey (**Annex B**). It is worthwhile to mention that the habitat preference for many fish species is not rigid. There are a few species that live exclusively in *beels* and a few that remain only in the rivers, while a few others exploit both habitats. On the other hand a number of exotic species are found in the *dogi*, which are likely to be escapees of the aquaculture ponds at the time of flooding.

Out of the total 70 fish species found in the survey, 8 species are identified as vulnerable, 6 species are endangered and one species is critically endangered according to the IUCN red book. The

⁴ CNRS 19XX.

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presence of threatened fish species in the habitats calls for preservation of these species. It is, therefore, recommended that fish species diversity be monitored throughout the year and steps taken to preserve them.

A total of 69 species of vegetation – vegetable, grass, leaf, medicinal plant, etc. have been recorded during the survey, of which 46 have been recorded in the *Char* areas while 54 have been recorded in the *Dogi* areas (**Annex-B**). In addition it is also suggested that two vegetation transect surveys – one in dry season and another in wet season – to assess growth and availability. People also catch birds and harvest mollusks; for lists of birds and mollusks see (**Annex B**). These species are also prevalent in the component area and should be monitored along with vegetation. Besides, people own large numbers of fishing gears and equipment to collect/harvest aquatic products; for list of the gears and tools see Table 19. The ownership of gears and tools should also be monitored along with other aquatic products.

3.3 Land Tenure Status

The well-being of rural households depends largely on access to and control over land. The land ownership pattern in the GNAEC area is highly skewed. In *Dogi* areas the land is generally passed down through inheritance with a small amount of land transferred through sales. In contrast, land has been granted in the *Char* areas through Government settlement, lease, or possession arrangements. Generally in newly accreted char areas the Government distributes land to the poor for settlement; the Government also leases out land for fish and agriculture, which often goes to the rich and elites. The land that is owned through the Government offers some protection to settlers but land obtained through squatting or possession arrangements is very insecure and vulnerable. The number of poor HHs occupying land without clear title is not small in both protected and unprotected *Chars*.⁵ In *Dogi* areas problems regarding land tenure are insignificant as most land is inherited; litigation is mostly limited to inheritance disputes. However in protected and unprotected char areas litigation regarding land ownership is very common among the poor. From the survey in protected char areas it appears that almost every household is caught up with at least one court case related with land ownership or false criminal offences resulting from land disputes. The land tenure situation of the poor that are occupying land under possession arrangement, both in protected and unprotected char areas, is much worse in this respect.

It appears from the study that the average farm size of poor households is not viable for sustaining a family because the amount of land held is small and unproductive. As a result of this, both the poor and non-poor HHs have to take up a variety of livelihood activities including a dependence on renewable natural resources.

The average holding size of the poor in waterlogged areas is about 0.60 acre while the average holding size of the non-poor is about 2.2 acres. The situation in settled (protected) *Char* areas is a little different; with average poor HH possessing 1.5 acres and non-poor HH possessing 3.3 acres. **Table 11** shows the land ownership pattern in *Dogi* and *Char* areas within GNAEC.

⁵ Protected Char = The Char developed by the Government/Development Agencies like CDSP II area.
Unprotected Char = The Char area which is not developed and is exposed to flood.

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Table 11: Land ownership pattern.

Target strata	No. of cases	Average land owned (in dec.) [Ha]		Total average land owned per HH (in dec.) [Ha]
		Ag. Land	Other land	
<i>Dogi</i> poor	50	44.8	14.8	59.6
<i>Dogi</i> non-poor	85	168.8	47.4	215.0
Char poor	14	107.1	41.4	148.5
<i>Char</i> non-poor	31	272.4	59.3	331.6
Total	180	143.4	40.8	184.1

Source: Field Survey in the GNAEC area, 2003.

Mortgage, lease and sharecropping arrangements are practiced but share cropping is the most common arrangement in the area. About 50-60 percent land owning HHs sharecrop out their land. The survey indicates that the waterlogged areas are single cropped – the farmers grow only a Boro rice crop. But there is a serious water crisis for irrigation – resulting in low yields. Some of the farmers try to cultivate T. Aman in the wet season but due to the prolonged and deep inundation, there is frequent crop failure. In *Char* areas there is no *Boro* cultivation due to salinity in ground water. People in *Char* areas mostly grow T. Aman under rain-fed condition with small amounts of *Aus* and/or *Rabi* crops; all of these are low-yielding crops reflecting the low quality of the land.

Table 12: Land use in crop production.

Strata	No. of sample HHs	No. and % of HHs owning land in <i>Dogi/Char</i>	Use of land in <i>Dogi</i> and <i>Char</i> areas for crop production by HH and % of total HHs owning land					
			HHs growing no crop	Only <i>Boro</i>	Only <i>Aman</i>	<i>Aus</i> + <i>Aman</i>	<i>Aus</i> + <i>Aman</i> + <i>Rabi</i>	<i>Boro</i> + <i>Aman</i>
<i>Dogi</i> poor	50	22 (44.0)	1 (4.5)	21 (95.5)	-	-	-	-
<i>Dogi</i> non-poor	85	66 (77.6)	5 (7.6)	61 (92.4)	-	-	-	-
Char poor	14	12 (85.7)	1 (8.3)	-	3 (25.0)	4 (33.3)	4 (33.3)	-
Char non-poor	31	31 (100.0)	-	-	4 (12.9)	9 (29.0)	17 (54.8)	1 (3.2)
Total	180	131 (72.8)	7 (5.3)	82 (62.6)	7 (5.3)	13 (9.9)	21 (16.0)	1 (0.8)

Source: Field Survey in the GNAEC area, 2003.

Due to the vulnerable situation in agriculture, people of this area are engaged in many non-farm activities. Due to out migration, labor shortages and high wage rates are prevailing in the peak period of agricultural activities. Because of low profits, the high cost of agricultural inputs and lack of irrigation facilities many households are not interested in intensification of agricultural activities.

Under common sharecropping arrangements the sharecropper receives 50 percent shares of the product. In addition the sharecropper is reported to receive Tk. 2,500 – 3,000 per hectare from the

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landowner as a part of input costs. Most landowners prefer to sharecrop land to a farmer who has adequate labor and can arrange for irrigation facilities.

3.4 Supply Chain Feed Demand Situation

The study team suggests that an extensive prawn cultivation approach with minimal to no supplemental feed be attempted. Under such a system there will be very little demand for feed for prawn and hence a very limited impact on natural resources (snails) caused by GNAEC promotion of prawn cultivation.

The recommendation to provide little to no supplemental feed is based on results in Bangladesh which show that the productivity and profitability of locally produced supplemental feeds is poor. However, in the main prawn growing areas of southwestern Bangladesh farmer perceptions of higher returns to feeding had led to destruction of natural feed resources (snails). However the production of homemade feeds based on locally available ingredients for immediate use (no storage requirement hence no spoilage) could be an employment option as an IGA alternative. The training given by GNAEC does not encourage the use of snails.

Even if farmers decide to provide supplemental feed they do currently have access to low cost trash fish from the Hatia area. These fish are low cost and (based on investigation) are not suitable for human consumption. Existing markets for trash fish are poultry feed mills and increased demand for prawn would only marginally impact the poultry industry.

4.0 Environmental Monitoring

The area has become a depressed basin due to polderization and the resulting siltation process in river and canal systems. This situation has affected agricultural activities, especially field crop production; previously two crops could be grown in this area, but the present situation in Dogi areas allows for only one crop in the dry season. During the wet season the area is inundated and provides habitat where fish, aquatic vegetation and other products grow. GNAEC provides aquaculture extension and other livelihood enhancement services in the area and intends to support the farmers of the component area in realizing the untapped potentials of the waterlogged lands. GNAEC has taken initiatives to provide support for fish polyculture along with rice and prawn culture in the waterlogged lands. The introduction of these techniques is bringing a shift in resource generation and distribution pattern in the targeted area. GNAEC intends to keep track and record the changes that will take place due these interventions in terms of socioeconomic and biological/environmental considerations.

The floodplain fisheries are very complex and dynamic. They vary considerably over the seasons, locations, and climatic conditions. They also experience substantial variations in productivity over time. Considering the characteristics of the natural fisheries and their degree of interaction with the local community, monitoring of the fisheries regime is important. Monitoring changes in the composition of wild life is also equally important in the light of Danida's EMP.

The waterlogged areas are inundated for 6-7 months over the year depending on the elevation of flooded land in *dogis*. Fisheries have tremendous importance for the livelihood of the local population. About 80 % households are involved in fishing in the inundated lands. A substantial number of the poor households depend on *dogi* fisheries for food and income during the monsoon.

The *Dogis* in the area have common features that characterize the fisheries regime which in turn is governed by the degree of connectivity to the river and canal systems. Following the inventory of the *Dogis*, monitoring locations are to be selected to represent the area.

Floodplain fisheries, with their spatial and temporal variations in fish and water availability, are as complex and dynamic as the fishing practices. The type of fishing gear used affects a fisher's catch within a specific habitat. The effectiveness of the fishers and their motivations are also significant in setting parameters for recording sample units. The selection of sample fishing units (a sample unit means one set of gear used for a catch attempt), while recording catch data, is crucial and it requires the judgment of the fisheries biologist. Accordingly, attempts should be made to be consistent so that the best possible estimates can be made from the collected data.

In order to collect representative data, considerations have to be made as to the intervals of sampling days, numbers and selection of gear for catch recording, spatial distribution of fishing gear, types of fishing gear, seasonal variations in catch within the sampling days. At the same time selection of parameters to monitor fish catch has to be made in a way that they will be relevant to the objectives of the monitoring effort. Details of sampling frequency, parameter selection, calculation of catch/harvest, and methods of wildlife and vegetation survey have been included along with the fish catch monitoring in the monitoring protocol (**Annex C**).

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5.0 Distribution of Impacts

5.1 Present situation

In GNAEC areas more than four out of five households poor and non-poor are involved in harvesting aquatic products for consumption and income. **Table 13 and 14** indicate the dependence on aquatic products and involvement in harvest by household and social strata.

In calculating the income of a HH, the survey considered all major sources of income. It appears from the survey that the majority of the HHs in GNAEC areas are somehow involved in harvesting aquatic products for different purposes; 80 percent of poor HHs and about 85 percent of non-poor HHs in *Dogi*, and 93 percent of poor HHs and 87 percent of non-poor HHs in *Char* areas, are involved in harvesting of aquatic products. **Table 14** provides further information that among the harvesting HHs, 46 percent of poor HHs and about 19 percent of non-poor HHs in the *Dogi* and 14 percent of poor HHs in *Char* areas, do not have any land in waterlogged areas but are engaged in harvesting of aquatic products. It confirms that there is open access to harvesting of aquatic products even from private lands; this traditional practice allows the poor HHs, having no land in *Dogi/Char areas*, to harvest aquatic products easily. These aquatic products contribute in cost-saving and direct incomes for harvesting HHs. Generally speaking, the harvesting of aquatic products and its contribution in income is not recognized. The study attempted to assess the importance of harvesting aquatic products and its contribution in income at HH level in *Dogi* and *Char* areas.

Table 13: Harvesting of aquatic products by HHs and strata.

Strata	Total no. of HHs.	No. and % of HHs owning land in <i>dogi/char</i>	Area of land per HH (in dec.)	No. and % HHs harvesting Aq. Product	HHs and % of total HHs			
					Owning land in <i>dogi/char</i>		Owning no land in <i>dogi/char</i>	
					Harvesting	Non – harvesting	Harvesting	Non – harvesting
Dogi poor	50	22 (44.0)	54.82	40 (80.0)	17 (34.0)	5 (10.0)	23 (46.0)	5 (10.0)
<i>Dogi</i> non-poor	85	66 (77.6)	100.26	72 (84.7)	56 (65.9)	10 (11.8)	16 (18.8)	3 (3.5)
Char poor	14	12 (85.7)	103.33	13 (92.9)	11 (78.1)	1 (7.1)	2 (14.3)	-
Char non-poor	31	31 (100.0)	21913	27 (87.1)	27 (87.1)	4 (12.9)	-	-
Total	180	131 (72.8)	121.04	152 (84.4)	111 (61.7)	20 (11.1)	41 (22.8)	8 (4.4)

Source: Field Survey in the GNAEC area, 2003.

It also appears that there is a difference between earnings of the harvesting and non-harvesting HHs. The earnings of the poor HHs involved in harvesting of aquatic products are generally higher both in *Dogi* and *Char* areas than the non-harvesting HHs. But the situation of the non-poor non-harvesting HHs is different because they are mostly undertaking non-agricultural activities for their

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livelihoods. **Table 14** shows the income situation by HH and strata and the total number of households involved in collecting products in GNAEC target areas.

Table 14: Annual income of target and non-target HHs

Strata	Total no. of HHs	Average annual income per household (in Taka)		
		All HHs	Non harvesting HHs	Harvesting HHs
Dogi poor	50	27,369	24,121	29,347
<i>Dogi</i> non-poor	85	126,506	228,469	108,007
Char poor	14	31,164	18,479	33,753
Char non-poor	31	77,246	97,681	74,584

Source: Field Survey in the GNAEC area, 2003.

Different HHs harvest different items of aquatic products mostly depending on their needs and demand. Catching fish for consumption and sale is the most common of all harvesting activities. The order of importance and priority, as noted by harvesting HHs, is collecting grass for cattle, leaves for compost, and mollusks for ducks and vegetables for home consumption. **Table 1** provides a picture of harvesting of different items of aquatic products by HH and strata. Harvesting activities are performed by both male and/or female members of harvesting HHs. As shown in **Table 15** women, particularly poor women are very much a part of harvesting wetland products.

Table 15: Participation of males and females in the harvest of aquatic products.

Strata	Total no. of sample HHs	Total harvesting HHs	No. of HHs from which males or females participate in the harvest	
			HHs from which MALES participate in harvest (% of total HHs)	HHs from which FEMALES participate in harvest (% of total HHs)
<i>Dogi</i> poor	50	40	37 (74.0)	20 (40.0)
<i>Dogi</i> non-poor	85	72	68 (80.0)	20 (23.5)
Char poor	14	13	12 (85.7)	8 (57.1)
<i>Char</i> non-poor	34	27	27 (87.1)	19 (61.3)

Source: Field Survey in the GNAEC area, 2003.

It may be noted that in many HHs both male and female members are involved in harvesting activities. However catching fish is mostly done by males, whilst collection of mollusks is done by females. In addition a large number of children are also involved in harvesting aquatic products. In

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these activities participation of female children is always higher because the male children are involved in fishing and other types of activities.

There are seasonal variations in the harvesting activities and values of aquatic products. It appears that most wetland activities start in *Asar* (June) and continue up to *Agrahayan* (December). It may be mentioned here that most of the items harvested from the *Dogi are to meet* their household demands (i.e. with the exception of a small proportion of fish and shellfish) they are consumed not sold. **Table 16** shows the consumption pattern of harvested aquatic products.

Table 16: Consumption pattern of harvested aquatic products.

Strata	Total no. of HHs	Consumption of aquatic products by sample HHs											
		Fish		Vegetable		Grass		Leaves		Mollusks		Birds	
		No. of HH	% of cons	No. of HH	% of cons	No. of HH	% of cons	No. of HH	% of cons	No. of HH	% of cons	No. of HH	% of cons
Dogi poor	50	35	96	33	100	13	100	10	100	30	93	4	100
<i>Dogi</i> non-poor	85	61	88	53	93	29	100	14	93	42	100	7	100
Char poor	14	12	78	7	100	5	100	8	100	12	100	1	100
Char non-poor	31	26	87	12	100	11	100	11	100	25	100	-	-
Total	180	134	89	105	97	58	100	43	98	109	98	12	100

Source: Field Survey in the GNAEC area, 2003.

It may be noted that the about 90 percent fish caught are consumed at the HH level and it is the major source of protein for the poor and non-poor in *Dogi* and *Char* areas. Cattle and ducks in *Dogi* areas also depend on aquatic products; there is not enough straw or grass that is produced in the *Dogi* areas, and duck rearing, as it is done in *Dogi* areas, would not be cost effective if feed would have to be bought from the market. Leaves are used for compost or to make heaps to grow vegetables. During the crisis food insecure periods (June to October), most poor HHs collect aquatic vegetables for their own consumption, as a crisis coping strategy.

Presently there is a big difference between per hectare incomes of *Dogi* and *Char* areas. The total annual income in *Dogi* areas is Tk. 16,167 per hectare while that in *Char* areas is Tk.10,448. The income is higher in *Dogi* areas because modern varieties of Boro crop is grown here, which has a higher yield than the other rice, crops in *Char* areas. In addition, longer inundation in *Dogi* areas provides greater scope for growth and harvesting of aquatic products.

5.2 Probable Future Situation

Presently in some areas people are implementing fish polyculture systems in waterlogged areas adopting the GNAEC approach, known as “Community Rice Fish Farming” as it is done jointly at

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community level. Some people also call it “Rice Fish Farming”. From this experience of scattered initiatives in Char and *Dogi* areas, it appears that the economic return from this kind of “Rice Fish Farming” is remarkably high. Another positive aspect of this approach is that it does not affect rice cultivation and its yield. From the focus group discussions it appeared that in addition this form of integrated agriculture reduces costs for land preparation and weeding.

“Rice Fish Polyculture” creates employment for local day laborers, more so than the labor requirement in rice cultivation. No real systematic calculation on labor requirement for “Rice Fish Polyculture” has been made but in our FGD sessions the present rice fish cultivators indicated its potentiality in creating employment for the poor. Farmers noted that major areas of employment would be: earthwork related with gher/bundh construction, maintenance of *gher/bund*, leveling of plots, and in some cases excavating duct along and inside the *bund*. Besides, it will also create new related enterprises like trading of fry/fingerlings of fish, and post larva/juvenile of prawn. Marketing of harvested fish and prawn will also be a new avenue for job seekers.

In general terms this total activity will create a need for infrastructure development, especially the rural road and power supply. The GOB and Danida have already initiated this process.

From the present experience it appears that potential economic return per unit area of land will increase at least 4 times in *Dogi* and *Char* areas by adopting rice white fish cultivation. In the case of prawn culture the economic returns per unit area will be much higher. Prawn cultivation revenues for extensive culture will be in the range of Tk 60,000 per HA. However, there are considerable negative effects in adopting this technology.

The component intends to expand the prawn aquaculture programme in Greater Noakhali district, especially in waterlogged areas under 4 Upazilas (52,000 ha in *Dogi* and 4,000 ha in *Char* areas). If the component were to convert the whole of this area into improved integrated prawn agriculture production units, approximately 85,000 collecting households (of about 100,000 households in the area), would have reduced access to wetland resources. Whilst the component has no intention of promoting change on such a massive scale it has commissioned this study to help study the negative effects of land use change. It is important to note that the seasonal flooding creating the *Dogi* landscape is an artificial manmade situation hence further modification will not be changing a natural ecosystem. Nevertheless the poorer section of the community currently depends to varying degrees on these man made wetlands.

The HHs who have land will be compensated by the income increase from prawn aquaculture. Negatively affected HHs will be those who have no suitable land but are involved in harvesting aquatic products now; their numbers are indicated in **Table 17**. The affected HHs can be categorized into three groups: marginally affected, moderately affected and severely affected. Marginally affected HHs are those whose income from the harvest of aquatic products contributes less than 10 percent to their total income. Moderately affected HHs are those whose income from the harvest of aquatic products contributes less than 30 percent to their total income. And severely affected HHs are those whose income from the harvest of aquatic products contributes more than 30 percent to their total income. However, it may be noted that the survey result indicated that there is no HH under the severely affected category. **Table 17** below indicates the number of HHs and degrees to which they are affected.

In the *Dogi* areas 35% of the landless families are marginally affected and 23% moderately so, whereas in the *Char* areas 8% from both categories are affected. The total from both categories being 47% of the landless population harvesting aquatic products from the manmade wetlands.

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Assuming that GNAEC is successful in promoting improved land use technology over 25% of the identified area, a total of approximately 10,000 households⁶ would be marginally or moderately negatively affected in terms of reduced access to the resource for the collection of aquatic products. The component will should therefore consider providing alternative income opportunities⁷ for these groups.

Table 17: No. of HHs impacted in Dogi and char areas.

Target Strata	Number of cases (samples)	No. of harvesting HHs	Degree of effect on different HHs			Total no. of affected HHs
			Marginally affected	Moderately affected	Severely affected	
<i>Dogi</i> poor	50	40 (80.0%)	14 (35%)	9 (23%)	-	23
<i>Dogi</i> non-poor	85	72 (84.7%)	11 (0)	5 (0)	-	16
Char poor	14	13 (92.9%)	1 (8%)	1 (8%)	-	2
Char non-poor	31	27 (87.1%)	-	-	-	-
Total	180	152 (84.4%)	26 (17.1%)	15 (9.9)	-	41

Source: Field Survey and Monitoring Data of GNAEC, 2003.

Worst Case Impact: If the entire 56,000 Ha area is brought into prawn cultivation about 65,000 will have reduced access to wetland resources. The potential exists for about 20,000 households to have reduced access to wetland products and also not be in a position to participate in prawn cultivation (due to a lack of suitable land). Of these 20,000 potentially impacted households about 6,500 will be marginally impacted and 4,000 moderately impacted.⁸ These impacted target households are primarily fisher families.

Fodder Impacts: In Bangladesh as pasture land declines, the population of cattle is declining, and the situation in the Greater Noakhali area, except in the Char areas, is alarming. A major reason for this decline is shortage of grass and straw. In the absence of grass people feed their cattle with aquatic vegetation for 7 - 8 months/yr. The introduction of aquaculture in waterlogged areas is likely to result in a serious shortage of cattle feed, which may deteriorate the situation of maintaining cattle. Similarly, fish culture in waterlogged areas will affect mollusk collection, which is likely to hinder duck rearing.

Fish culture in waterlogged areas will limit the growth of any aquatic vegetation, and people will not be able to make compost. It will also reduce the collection of aquatic vegetables for home consumption.

Due to arsenic contamination and salinity intrusion of ground water in the area and shortage of safe potable water, many people use water from the *Dogi areas* for domestic purposes in the wet season. In the event of more intensive land use via integrated rice-fish agriculture it is possible that access

⁶ 85,000 households x 25% area x 47% affected

⁷ Employment for earthworks in the integrated production systems, fry trading, harvesting and marketing.

⁸ Marginal impacted means that less than 10% of income comes from the wetlands, moderately impact is for 20%, and severely is for over 30% of income from the wetlands. No households in the survey would be severely impacted.

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to this water will be reduced. In terms of human health this may be an advantage as coliform contamination in flooded areas can be a serious problem.

Boundaries. Rice Fish Farming at a community level has already created some problems in fixing boundaries of plots (*ails*) at the end of the fish harvest period. Land preparation is needed prior to fish culture in rice land: plowing and leveling. As a result, plot boundaries (*ails*) are lost. Later on in the process of plot reallocation it becomes difficult and can create confusion, and in some cases it leads to conflict within the community – such conflicts have to be resolved through village/Union level arbitration.

The high profit from fish/prawn culture in Char area has stimulated interest amongst the community and has started fish/prawn cultivation in rice fields in the settled Chars. It is feared that the rich and powerful will start large scale prawn production as seen in the SW of Bangladesh. Some say that poor people within such big ‘*ghers*’ will not be able to operate rice cum prawn production independently. However the experience from the SW has also shown that the small production units managed by marginal farmers are more efficient and yield a higher profit per unit area due to the increased care provided by the household members. Experience to date in the GNAEC command area has shown that small production units have many social benefits apart from those brought by increased income. These include increased employment opportunities in the area and as a result improved security for vulnerable family members as the men do not have to migrate away from the District in search of labor.

In the unprotected Char areas where land tenure is weak the situation may be different as the potential land for distribution amongst poor could be stolen by local mafia operating beyond the law. It is in these areas that the GoB needs to take special care with its settlement policies to ensure that land distribution is fair and caters for the needs of both the landless and larger aquaculture operations. There is already evidence of the negative effects of large scale unplanned illegal aquaculture instigated in Khas lands. GNAEC and CDSP II are working actively to ensure that large-scale commercial aquaculture has to have Environmental Impact Assessments prior to the start up of activities. The Coastal Development Strategy, currently under development by the GoB/Netherlands Government/DFID Integrated Coastal Zone Management Project, will help identify land use zones to ensure that unplanned intensive aquaculture is not allowed

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6.0 Recommendations

Overall the study team recommends that GNAEC program for prawn cultivation cautiously proceed. The potential economic benefits are very large while environmental and negative social impacts are minimal or can be minimized. To ensure effective implementation of the programme in accordance with Danida and ASPS objectives the following specific recommendations are made:

Monitoring. A monitoring plan should be put in place to make sure that programme interventions are in fact not having significant negative impacts. This plan should include a biodiversity /fisheries monitoring plan within the context of the Danida Environmental management Plan and an assessment of the economic impact of households losing access to wetland resources. Details for an implementation plan for a suitable environmental monitoring approach are provided in **Annex C**. The household survey for assessment of wetland product use should be repeated after 2 years of implementation to determine actual impact.

To manage these monitoring activities the M&E unit of GNAEC should be strengthened to include an expert (staffs and/or consultants) capable of implementing the environmental monitoring plan and to manage the sample based household survey (to be done with either internal program staff resources or through an outside organization).

Extensive Production. It is recommended that the production systems being promoted not be based on the use of supplemental feed. This is consistent with both profit maximization and minimizing environmental impact. Fisheries experts working on this study have concluded that much of the supplemental feed provided in extensive systems is not productively employed and in fact represents a waste of resources. In the process of promotion, demonstration trials should be undertaken to show that limited input systems can yield higher profits. These demonstrations should be closely managed by GNAEC and independent researchers.

Programme Targeting. GNAEC should ensure that participants are members of the Danida target group. To facilitate the formation of *Dogi*-wise prawn & fish culture, organizations where the poorest section of the community are included as members should be promoted. GNAEC should continue to develop linkages between these groups and the private PL hatcheries.

Negative Impact Mitigation: Income programme. The programme will have a significant negative impact on a limited number of families that harvest fish and collect aquatic products from the wetlands under the current seasonally fallow regime. These families (primarily fisher families) should be extended programme activities to increase their incomes through alternative income sources. These activities should include PL transport, harvesting and marketing associations. The finalization of activities should be done through a participatory process with the fisher families that will be negatively impacted by the expansion of prawn cultivation.

Identification of affected households can be conducted through a community level PRA process to identify fisher and other impacted households. This exercise will require either PRA training for GNAEC staff and/or use of outside PRA expert facilitators.

Infrastructure Issues. The GNAEC should discourage construction of dikes on each plot boundary within the *Dogi*. Arrangements should be made to reduce monsoon and boro rice drainage congestion. GNAEC can also assist in the identification of areas suitable for bio-diversity conservation (sanctuaries) where the prawn cultivation is not undertaken. These could be rotating in nature. This advocacy and planning should be undertaken in close cooperation with the ICZM

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project which has significant planning resources and capacities and other active programs in the GNAEC program area.

Land Tenure. The programme should be undertaken only in areas where smallholders have secure rights to the land. This occurs where land is primarily inherited and not provided through the government. In these and other program areas GNAEC should facilitate institutional and legal support for poor households (HHs) recently acquired land.

Concentrate in Dogi areas. The study team recommends that primary emphasis be placed on *Dogi* areas (as opposed to *char* areas). Farmers have more secure land rights. This is consistent with the current GNAEC plan.

Annexes

Annex A. Danida Environmental Management Plan - Action No. 13

Action No 13 details as defined in the Danida EMP include:

Rationale for the action: There are a number of environmental concerns that have arisen with development of freshwater prawn (golda) culture in Bangladesh. Most experience comes from the CARE GOLDA project in Khulna and Bhagerhat in SW Bangladesh. The environmental problems in this area include collection of wild prawn seed for stocking, use of snails for feed causing pollution of ponds, prawn disease and building of dikes across wetlands.

While the environmental situation in Noakhali is different from SW Bangladesh, to avoid potential future environmental problems arising in component areas, a set of environmental management guidelines should be prepared incorporating current best practice and these should be strictly implemented in the extension approach used by the component. These should address issues concerning the use of feed, diversification of farming systems to ensure poor farmers are not subject to undue risk from prawn crop failure, planning of ponds in ways that do not impact common wetlands, and other relevant issues.

An important dimension to prawn farming in Bangladesh lies in the brackish water areas of Patuakhali/Barguna and Greater Noakhali. There are many poor people, including women and children, involved in destructive fishing practices for collection of prawn and shrimp fry for aquaculture. GNAEC has already taken steps to avoid such problems via the promotion of private sector prawn hatcheries designed to cater for the forthcoming demand for prawn seed. To date private companies have built two units with technical assistance from Danida. The combined capability of these hatcheries is 15 million PL/yr. which is enough seed to stock 1,500ha of ghers equivalent to 10,000 household production units. The current hatchery capacities could be doubled at the existing sites in the event of increased demand. As with fish seed production yet further demand would stimulate further hatchery development.

Objective: Environmentally sound development of prawn aquaculture in Greater Noakhali

Outputs:

- To prepare environmental management guidelines that will avoid potential negative environmental impacts from development of golda culture in component areas.
- To identify environmentally sound livelihood alternatives for poor women and children involved in collection of wild golda fry and for landless groups dependent on seasonal access to manmade wetlands

- The expected results of the action would be an environmentally sound development of golda culture in the Greater Noakhali area.

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Annex B. Socio-economic status

Table B1: Housing condition of target and non target HHs.

Strata	Total no. of HHs	No. and percentage of HHs having different housing conditions								Access to Electricity
		Floor Condition		Roof Condition			Wall condition			
		Semi pucca/ pucca	Kutchra	Pucca	Tin/ Tiles	Light mat.	LM	T/B/ wood	Semi-pucca/ Pucca	
Dogi poor	50	1 (2.0)	49 (98.0)	-	46 (92.0)	4 (8.0)	14 (28.0)	35 (70.0)	1 (2.00)	15 (30.0)
<i>Dogi</i> non-poor	85	9 (10.7)	76 (89.3)	4 (4.8)	78 (92.9)	2 (2.4)	11 (13.1)	60 (71.4)	13 (15.5)	55 (64.7)
Char poor	14	-	14 (100.0)	-	5 (35.7)	9 (64.3)	5 (35.7)	7 (50)	2 (14.3)	-
Char non-poor	31	3 (9.7)	28 (90.3)	-	11 (35.5)	20 (64.5)	9 (29.0)	22 (71)	-	-
Total	180	13 (7.3)	167 (92.7)	4 (2.2)	140 (78.2)	35 (19.6)	39 (21.8)	124 (69.3)	16 (8.9)	70 (38.9)

Source: Field Survey in the GNAEC area, 2003.

Table B2: Use of tube -well water for domestic purposes.

Strata	Total no of HHs	No. of HHs using tube-well water for domestic purposes							
		Drinking		Cooking		Washing		Bathing	
		Dry season (% of total HHs)	Wet season (% of total HHs)	Dry season (% of total HHs)	Wet season (% of total HHs)	Dry season (% of total HHs)	Wet season (% of total HHs)	Dry season (% of total HHs)	Wet season (% of total HHs)
Dogi poor	50	50 (100.0)	48 (96.0)	1 (2.0)	-	2 (4.0)	1 (2.0)	1 (2.0)	-
<i>Dogi</i> non-poor	85	82 (96.5)	80 (94.1)	3 (3.5)	4 (4.7)	6 (7.1)	5 (5.9)	4 (4.7)	4 (4.7)
Char poor	14	13 (92.9)	12 (85.7)	-	-	-	-	-	-
Char non-poor	31	27 (87.1)	27 (87.1)	-	-	-	-	-	-
Total	180	172 (95.6)	167 (92.8)	4 (2.2)	4 (2.2)	8 (4.4)	6 (3.3)	5 (2.8)	4 (2.2)

Source: Field Survey in the GNAEC area, 2003.

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Table B3: Access to latrine by HHs of different strata.

Strata	No. of sample HHs	No. of HHs having access to latrine (% of total HHs)	Types of latrine used		Access to latrine during rainy season (% of total HHs)	More than one latrine (% of total HHs)
			Water sealed (% of total HHs)	Kutcha (% of total HHs)		
<i>Dogi poor</i>	50	49 (98.0)	23 (46.0)	26 (52.0)	40 (80.0)	-
<i>Dogi non-poor</i>	85	85 (100)	63 (74.1)	22 (25.9)	77 (90.6)	10 (11.8)
Char poor	14	14 (100)	5 (35.7)	9 (64.30)	14 (100)	-
Char non-poor	31	31 (100)	21 (7.7)	10 (32.3)	30 (96.8)	4 (12.9)
Total	180	179 (99.4)	112 (62.2)	65 (37.2)	161 (89.4)	14 (7.8)

Source: Field Survey in the GNAEC area, 2003.

Table B4: Adoption of rice varieties by target and non-target HHs.

Strata	Total no. of HHs	Area of land Per HH (in dec.)	HHs owning land in Dogi			
			No. of HHs owning land (% of total HHs)	HHs owning land but not cultivating rice (% of total HHs)	HHs cultivating rice	
					Cultivating local varieties (% of total HHs)	Cultivating modern varieties (% of total HHs)
<i>Dogi poor</i>	50	54.82	22 (44.0)	1 (4.5)	3 (6.0)	18 (36.0)
<i>Dogi non-poor</i>	85	100.26	66 (77.6)	5 (7.6)	12 (14.1)	49
Char poor	14	103.33	12 (85.7)	1 (8.3)	5	6
Char non-poor	31	21913	31 (100.0)	-	14	17
Total	180	121.04	131 (72.8)	7 (5.3)	34	90

Source: Field Survey in the GNAEC area, 2003.

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Table B5: Availability trend of aquatic products during last ten years.

Type of aquatic products	Strata	Total sample HHs	Availability Trend – response of sample HHs			
			Reduced (% of total HHs)	Remained same (% of total HHs)	Increased (% of total HHs)	Total (% of total HHs)
Fish	Dogi poor	50	31 (88.6)	2 (5.7)	2 (5.7)	35 (100.0)
	Dogi non-poor	85	53 (86.9)	5 (8.2)	3 (4.9)	61 (100.0)
	Char poor	14	11 (91.7)	1 (8.3)	-	12 (100.0)
	Char non-poor	31	21 (80.8)	4 (15.4)	1 3.8	26 (100.0)
Aquatic Vegetables	Dogi poor	50	26 (78.8)	6 (18.2)	1 3.0	33 (100.0)
	Dogi non-poor	85	37 (69.8)	14 (26.4)	2 3.8	53 (100.0)
	Char poor	14	7 (100.0)	-	-	7 (100.0)
	Char non-poor	31	8 (66.7)	2 (16.7)	2 16.7	12 (100.0)
Aquatic Grass	Dogi poor	50	5 (38.5)	4 (30.8)	4 30.8	13 (100.0)
	Dogi non-poor	85	17 (58.6)	10 (34.5)	2 6.9	29 (100.0)
	Char poor	14	4 (80.0)	1 (20.0)	-	5 (100.0)
	Char non-poor	31	7 (63.6)	1 (9.1)	3 27.3	11 (100.0)
Aquatic Leaves	Dogi poor	50	7 (70.0)	3 (30.0)	-	10 (100.0)
	Dogi non-poor	85	8 (57.1)	6 (42.9)	-	14 (100.0)
	Char poor	14	7 (87.5)	1 (12.5)	-	8 (100.0)
	Char non-poor	31	5 (45.5)	4 (36.4)	2 18.2	11 (100.0)
Mollusks	Dogi poor	50	19 (63.3)	9 (30.0)	2 6.7	30 (100.0)
	Dogi non-poor	85	26 (61.9)	13 (31.0)	3 7.1	42 (100.0)
	Char poor	14	10 (83.3)	2 (16.7)	-	12 (100.0)
	Char non-poor	31	14 (56.0)	5 (20.0)	6 24.0	25 (100.0)
Birds	Dogi poor	50	2 (50.0)	1 (25.0)	1 25.0	4 (100.0)
	Dogi non-poor	85	6 (85.7)	1 (14.3)	-	7 (100.0)
	Char poor	14	1 (100.0)	-	-	1 (100.0)
	Char non-poor	31	-	-	-	-

Source: Field Survey in the GNAEC area, 2003.

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Table B6: Fish species harvested from the Dogi and Char during last season.

Sl. No	Name of Fish Species	Harvested/ Collected in		Sl. No	Name of Fish Species	Harvested/ Collected in		Sl. No.	Name of Fish Species	Harvested /Collected in	
		Char	Dogi			Char	Dogi			Char	Dogi
1	Jat puti	3	3	26	Taki	3	3	51	Guda echa		3
2	Tit puti (VU)	3	3	27	Shol	3	3	52	Chokuni		3
3	Thai shar puti	3	3	28	Gojar (EN)	3	3	53.	Telapia	3	3
4	Mola	3	3	29	Cheng (VU)	3	3	54.	Teragura		3
5	Chela	3	3	30	Air (VU)	3	3	55.	Dhaiua		3
6	Chep Chela	3	3	31	Bajari Tengra	3	3	56.	Pangash (CE)		3
7	Ranga Chanda (VU)	3	3	32	Thengua Echa	3	3	57.	Nilontika		3
8	Lamba Chanda	3	3	33	Rekha Kolisha	3	3	58.	Bigh head	3	3
9	Gol Chanda	3	3	34	Kecho Baim	3	3	59.	Kaligonna		3
10	Chapila	3	3	35	Golsha/kabashi tengra(VU)	3	3	60.	Koral	3	3
11	Khalisha	3	3	36	Tengra (EN)	3	3	61.	Lakka		3
12	Lal khalisha	3	3	37	Boal	3	3	62.	Minor cup		3
13	Chuna khalisha	3	3	38	Kali Pabda (EN)	3	3	63.	Baycha	3	
14	Dankina (EN)	3	3	39	Madhu Pabda (EN)	3	3	64.	Loklok	3	
15	Meni/Bheda (VU)	3	3	40	Shing	3	3	65.	Katla	3	3
16	Koi	3	3	41	Magur	3	3	66.	Grass carp	3	
17	Kali/Napit koi (EN)	3	3	42	Foli (VU)	3	3	67.	Karfu	3	
18	Khachki	3	3	43	Rui	3	3	68.	Shiring	3	
19	Kaikla	3	3	44	Mrigel	3	3	69.	Bata (VU)	3	
20	Gutum	3	3	45	Kalibaush	3	3	70.	Kali baycha		3
21	Tin Choka	3	3	46	Gura Echa	3	3				
22	Boro Baim	3	3	47	Tepa	3	3				
23	Guchi Baim	3	3	48	Dimua/Kthalia Echa	3	3				
24	Tata Baim (VU)	3	3	49	Bele	3	3				
25	Kuicha	3	3	50	Golda	3	3				

Note: Local Status of Some Fish as per IUCN red book - (Species CE = Critically Endangered, EN = Endangered VU = Vulnerable)

Source: Field Survey in the GNAEC area, 2003.

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Table B7: Aquatic vegetables collected/observed in the Dogi and Char (water logged land)

Sl. No.	Name of aquatic vegetable	Type of Respondent		Sl. No.	Name of aquatic vegetable	Type of Respondent		Sl. No.	Name of aquatic vegetable	Type of Respondent	
		Char	Dogi			Char	Dogi			Char	Dogi
1	Alicha	3	3	26	Tobdabi	3	3	51	Chod khere		3
2	Chera	3	3	27	Helench	3	3	52	Ghora dupa	3	3
3	Shapla	3	3	28	Chenga mua	3	3	53	Bon marich		3
4	Hogla	3	3	29	Echa ganja		3	54	Bon til	3	
5	Hotka	3	3	30	Refuji pata	3	3	55	Kash	3	3
6	Jhara	3	3	31	Chackhuni	3	3	56	Japani lata	3	3
7	Shaluk	3	3	32	Chiringa	3	3	57	Tej pata jatio gach		3
8	Batua shack	3	3	33	Tituni Pata		3	58	Kanai lata	3	3
9	Dulabanga shack	3	3	34	Thoash			59	Chan	3	
10	Dall/noll	3	3	35	Kaicha gach	3	3	60	Amashoy lata	3	3
11	Kalmi	3	3	36	Hiyash muti	3	3	61	Adamoni	3	
12	Kharia	3	3	37	Badha ghash		3	62	Bhorga/bogra	3	
13	Ghash	3	3	38	Chotra pata		3	63	Hula jangla	3	
14	Malicha	3	3	39	Bish katali		3	64	Boisha lata	3	
15	Bot kalmi /dhole/hena	3	3	40	Motmoti			65	Charpa	3	
16	Kachuri pana	3	3	41	Gurguria shack			66	Mara dupa	3	
17	Holla		3	42	Kachu shack	3	3	67	Karmutta	3	
18	Moida mura		3	43	Dima shach	3		68	Ankuni		3
19	Chikon durba	3	3	44	Shaola			69	Ghagra		3
20	Kadom		3	45	Kurmoti pata		3				3
21	Choch	3	3	46	Gura hena		3				
22	Ramdopa	3	3	47	Arailla		3				
23	Dheki shack		3	48	Jarga hena		3				
24	Boicha pata	3	3	49	Hula hena	3	3				
25	Khudi pana	3	3	50	Kumari lata						

Source: Field Survey in the GNAEC area, 2003.

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Table B8: Aquatic birds observed in the Dogi and Char (waterlogged land).

Sl. No.	Birds	Observed in		Sl. No.	Birds	Observed in	
		Char	Dogi			Char	Dogi
1	Bok	3	3	23	Charui	3	3
2	Pankouri	3	3	24	Chop pakhi		3
3	Harial	3	3	25	Dengura	3	3
4	Gangria	3	3	26	Chil	3	3
5	Bhundi	3	3	27	Jangli hash	3	3
6	Machranga	3	3	28	Kachi hash		3
7	Gaang Chil	3	3	29	Bon hash		3
8	Tia	3	3	30	Kana kua	3	3
9	Baila hash	3	3	31	Chega	3	3
10	Kachi chora		3	32	Jegi/Hegi		3
11	Baijja hash	3	3	33	Baj pakhi	3	3
12	Dahuk	3	3	34	Bhetalay		3
13	Dowel	3	3	35	Kurailla		
14	Koack/Oack	3	3	36	Haila	3	3
15	Ghughu	3	3	37	Aikuri	3	
16	Pecha	3	3	38	Shakun	3	
17	Kack	3	3	39	Haruli	3	3
18	Bajhori			40	Hacha	3	3
19	Shalik	3	3	41	Titi hash	3	
20	Kora	3	3	42	Chandani	3	
21	Kurba	3	3	43	Koal		3
22	Chaba	3	3				

Source: Field Survey in the GNAEC area, 2003.

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Table B9: Aquatic Mollusks observed in the Dogi and Char (waterlogged land).

SL. No.	Mollusks/Jhinuk/crab	Observed in	
		Char	Dogi
1	Shamuk	3	3
2	Jhinuk	3	3
3	Crab	3	3
4	Gari	3	3

Source: Field Survey in the GNAEC area, 2003.

Table B10: Ownership of gears/tools.

Gears/tools	No. of HHs owning gears/tools				Total HHs. (180)
	Dogi poor (50 HHs)	<i>Dogi</i> non-poor (85 HHs)	Char poor (14 HHs)	Char non-poor (31 HHs)	
Having gears/tools of any kind	49 (98.0)	83 (97.65)	14 (100.0)	31 (100.00)	177 (98.3)
Having Jal (net) of any kind	37 (74.0)	68 (80.0)	11 (78.6)	28 (90.32)	144 (80.0)
<i>Khora Jal</i>	2 (4.0)	2 (2.4)	-	1 (3.2)	5 (03.0)
<i>Thela Jjal</i>	26 (52.0)	46 (54.1)	3 (21.4)	13 (41.9)	88 (48.9)
<i>Koia Jal</i>	17 (34.0)	44 (51.8)	6 (42.9)	11 (35.5)	78 (43.3)
<i>Jhanki Jal</i>	20 (40.0)	50 (58.8)	7 (50.0)	22 (71.0)	99 (55.0)
Koanch	19 (38.0)	38 (44.7)	4 (28.6)	13 (41.9)	74 (41.1)
Barshi	20 (40.0)	45 (52.9)	6 (42.9)	20 (64.52)	91 (50.6)
Chai	11 (22.0)	31 (36.5)	4 (28.6)	21 (67.7)	67 (37.2)
Da	49 (98.0)	82 (96.5)	14 (100.0)	31 (100.0)	16 (97.8)
Khonta	41 (82.0)	78 (91.8)	13 (92.9)	30 (96.8)	162 (90.0)
Bird's Trap	6 (12.0)	8 (9.4)	-	1 (3.2)	15 (08.3)
Other	5 (10.0)	11 (12.9)	3 (21.4)	7 (22.9)	26 (14.4)

Source: Field Survey in the GNAEC area, 2003.

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Annex C. Biological Monitoring Protocol

Introduction

The GNAEC area includes 14 upazilas under three districts namely Noakhali, Feni and Lakshmipur. During the late 50's and early 60's the component area was poldered to protect the area from natural hazards like storm surges. Following the polderization process during the last 20 years siltation in and around the polder has created some depressed basins. In these basins drainage congestion has become a common feature and the majority of the land remains underwater for periods of 6-8 months/yr. The farmers cultivate only one boro (HYV) crop (late Amon) these depressed areas are locally known as *dogi*. In the *dogis* there are natural fish and other aquatic products like grass, vegetables, snails and others. Technological development creates an opportunity for utilizing the water logged flooded land via integrated agriculture practices like rice cum fish/prawn production. GNAEC is providing Aquaculture extension and other livelihood enhancement services in the area and intends to support the farmers of the component area in realizing the untapped potentials of the waterlogged lands. As such an initiative has been taken to provide support to culture prawn along with white fish in the *dogis* in addition to the Boro (late Amon) cultivation. There would be a shift in resource generation and distribution pattern of the value added in the targeted area following the prawn culture introduction. GNAEC has decided to keep track and record the changes following interventions both in terms of socioeconomic and biological and environmental considerations.

Considering the characteristics of the natural fisheries and its degree of interaction with the local community, GNAEC has opted for the monitoring of the component intervention areas and seasonal surveying of wild life and vegetation. Winrock International has developed the biological monitoring protocol for GNAEC.

Goals and objectives

The goal of the biological monitoring protocol is to provide GNAEC with tools to capture the data and information on the biological and environmental changes due to component interventions. Fishery data includes the yield from open water fish production and aquaculture, species availability and diversity over the time and space. Monitoring will also be done to gather information on environmental aspects. Specific objectives of the monitoring are to:

- Capture localized (site-specific) changes in fisheries yield and species diversity
- Capture changes in the vegetation and wild life regimes (seasonal survey)

Rational for monitoring

About 84 % of the *Dogi* households are involved in fisheries, either for consumption or as a means of income generation. During the monsoon period a substantial part of households depend entirely on *dogi* fisheries. It is assumed that there would be a change in the biological regime due to GNAEC interventions in the component areas. In order to capture the changes in the biological regime, it is felt that fish catch monitoring is necessary whilst for the wildlife and vegetation aspects a seasonal survey would be required.

Monitoring parameters

Fish catch assessment monitoring collects data on fishing intensity, species diversity, catch composition, fishers by category and fishing gear using a data form (to be developed). The data gathered on these parameters will act as a benchmark for future measures, for floodplain production and for information on fish species diversity. The terminology may be defined as follows:

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Fishing gear and fishers:

- fishing gear type and number, and mesh size
- fishers type, sex, age, village and distance from fishing ground

Time and duration of fishing:

- fishing starting and ending times
- probable fishing duration

Fish catch:

- species by number and weight

Fishing rights:

- the fisher's access to the fishing ground

Methodology

To collect information and data mainly the following methods will be applied:

- Fish catch monitoring
- Seasonal wildlife and vegetation survey
- Focus group discussions mainly for qualitative data

The study area

The component area covers greater Noakhali, a coastal district. On the basis of physical characteristic the area is categorized by two types' viz. (i) Dogi and (ii) char land. The impact monitoring protocol is being developed for the *Dogi* and the Char. Dogis potential for prawn fish culture are spread over Ramgonj, Chatkhil, Begumganj and Noakhali sadar Upazilas. The water logged area remains inundated for 6-8 months over the year depending on the elevation.

Inventory of Dogi and Char lands

In order to optimize the efforts and to draw a representative sample area, an inventory of the *dogi* will be conducted prior to start regular monitoring. Following information will enable to draw sample areas for monitoring.

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Table C1. Biodiversity monitoring programme data collection methods.

Data required	Detailed features	Method
1. Name of the <i>dogi/char land</i>	Record name (if any) and address	Discuss people
2. Overview of the wetland and description	Identify <i>dogi</i> , burrow pit, <i>pagar</i> General description including water retention, depth, extent (Avg. area) and connectivity with river or canal system	Observation Official record for area
3. Ecological features including land use	Main habitat and vegetation types (submerged, free floating, rooted floating, crop field, etc.)	- Observation and discussion
4. Land tenure, Ownership of the site and name of the villages around	Ownership and tenure system & status. Name of the villages of intensive user of the <i>Dogi</i>	Discussion with the people
5. Fishing methods	Describe who fishes, when, how, techniques, major gears used and others	- Observation and discussion
6. Noteworthy fauna	fish, amphibians, reptiles, aves, mammals	- Observation and discussions
7. Noteworthy flora	submerged, free floating, rooted floating, sedges & meadows, crop field	- Observation and discussions

Monitoring site selection

Following the inventory data/info analysis monitoring locations will be selected to represent the area.

Sampling frequency and sampling protocol

Floodplain fisheries are as complex and dynamic as there is spatial and temporal variations in fish & water abundance and the fishing practices. A sample unit was considered to be one set of gear used for fish catching.

The fish catch-monitoring data should be collected on about a monthly interval from all the selected monitoring locations through out the year. Fishing practices is complex in the floodplain habitats. There is variation of the fishing gears, timing & duration of fishing among the fishermen types, habitat types (seasonal & perennial) etc. So selection of sample units is a very hard task. However, attempt will be made to maintain data consistency so that the best possible estimates of the parameters will be made by using data to be collected through monitoring.

The Monitoring staff will gain an idea prior to starting the monitoring programme such as the fishing practice, gears usually operated, intensities, duration of fishing etc. in the specific monitoring locations.

The monitoring staff upon arrival to the monitoring location on monitoring day would assess the fishing activities and accordingly make a plan for sampling for that very day. Data form has to be form in consultation with the local people and the GNAEC authority. To avoid any bias from the spatial distribution of fishing gear used the monitoring staff will collect data from different spots at the monitoring locations.

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Following outline should be followed by the monitoring staff:

Data would be collected from all types of gears operated on that day from the monitoring area delineated before hand

Up to 10 operational units of a specific gear, data from at least 3 units to be collected

From 11 to 20 operational units of a specific gear, data from at least 4 units to be collected

From 21 to 30 operational units of a specific gear, data from at least 5 units to be collected

For over 30 operational units of a specific gear, data from at least 6 units to be collected

Upon deciding the number of units to be sampled for specific gears, the selection of sampling gears (let say 3) will be made spatially distributed (bank, middle, east, west, south, north etc.) over the monitoring locations and over the day (morning, noon, afternoon)

Total number of operational gears by type on that day will be recorded

For passive gears (long line, current jal, traps) selection of number of individuals will be made and the number of gears will be recorded as well while recording total number of operational gears of that type

In case of kua/khata fishing and dewatering successive fishing day's data will be collected using special form.

Output and Analysis

The analysis will be made on the catch seasonally, monthly, by monitoring locations, by gears, by fisher types. CPUE, CPUA, fishing duration, fishing intensities and species diversity. The extrapolation will be done over the day/month/season/year, over the monitoring locations and over the study area.

The fish catch can vary spatially, temporally, and on the basis of the ecological condition of the habitat. In order to incorporate these variations and to monitor parameters reconnaissance field visits, observation of the fishing and caught fish for a day long endeavor and focus group discussion with fisher of the area has been considered.

Seasonal variation: In the targeted area fishing continues from June to December and could be distinguished into three slots in accordance with the intensity of fishing and the availability in to June-Aug, Sept-Oct. and Nov. -Dec.

Fishing gear: The types of fishing gear in operation during the monitoring will be recorded. For Current *jal* length will be recorded and for hooks no. will be recorded if used in along line.

Fishing intensity and duration of fishing: Fishing intensity describes the amount of gear used during the monitored day. This will be calculated from an average of three sampling days. Gear numbers of all types will be counted and then extrapolated for that month. Fishing duration will be recorded for all the operated gear and the average duration of fishing will be calculated for each specific gear type.

Catch per Unit of Effort (CPUE): The average catch in kilograms per unit gear per hour of operation.

Calculation

The gathered data upon cleaned and screened following conversion is done before proceeding calculation using access soft ware

Conversion of Sub-Sample Catch into Sample Catch

Conversion of Observed Time Catch into Day Catch

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Current Jal /long line will be standardized on Length/ no.

C.P.U.E = (Total Catch of a specific gear type observed during monitored days by habitat for a month)/ (No. of observed gears for a specific gear type during those monitored days by habitat for that month) = Kg/Gear/Day

Catch per Unit of Area (CPUA): The total catch of all gear per unit area over a year extrapolated from sample data.

The calculation procedure for CPUA

We have,

C.P.U.E = (Total Catch of a specific gear type observed during monitored days by habitat for a month)/ (No. of observed gears for that specific gear type during those monitored days by habitat for that month) = Kg/Gear/Day

Then, Total Catch of a specific gear for one day = C.P.U.E * No. of operated gears of that type in a day

Then, Total Catch of all types of gears operated = Σ Total Catch of a specific gear for one day
Total Catch for a month = Total Catch of all types of gears operated * No. of days of a month

Finally, C.P.U.A = (Σ Total Catch of All Month/Area of a Monitoring Location = Kg/ha/year

Catch composition: The catch composition will be analyzed in percentage for the obtained species and the total catch of a specific habitat.

Species diversity: The observed species diversity (each species is considered only once for calculating species diversity i.e. union algorithm will be used) for each monitoring location will be considered as the α diversity. The zonal species diversity will be considered as the β diversity (e. g. GNAEC component site) for fish species.

Vegetation species diversity: Data will be collected by direct field observation and by interviews with the local people. Quadrant qualitative (for aquatic vegetation) and quadrat quantitative (for terrestrial vegetation) methods also be used in this survey. After visiting the field, transects will be drawn based on vegetation diversity, occurrence and habitat types. For the aquatic vegetation 4m² quadrates from each transect will be examined. The occurrence of the species in this instance will be listed following the union algorithm.

Wild life species diversity: The following methods will be used for recording presence, for identification and for gathering information. Presence or absence will be determined in both general surveys and transects

- Transect lines will be drawn across the observed habitats
- Plot counting to enumerate the density of amphibians and slow moving reptilian species
- Dropping counts for mammals and predatory birds
- Flashing for nocturnal birds
- Photography, call, and trap collection of specimens for taxonomic confirmation
- Block counting for fast moving reptiles, birds and mammals
- Interviews with local people such as fishers, boatman, forest wood collectors and other professionals